TABLE OF CONTENTS

List of Exhibits

APPENDIX A: DEVELOPMENT OF THE LEVEL-OF-EFFORT TIERS

Listed in this appendix are the assumptions and methodologies employed in determining four BMP (including point source technologies) implementation levels for the three tiers and "Everything, Everywhere, by Everyone" (E3) scenarios. The scenarios were developed by the Chesapeake Bay Program's Nutrient Subcommittee Workgroups to provide reference points for load reductions of nutrients and sediment that could be associated with increasing levels of BMP implementation for both point and non-point sources in the Bay watershed. The UAA workgroup was provided with examples of the types of BMPs and implementation levels to develop a defensible costing tool. These four scenarios range from Tier 1, which represents the current level of implementation throughout the watershed plus regulatory requirements implemented through the year 2010, up to a limit of technology scenario referred to as E3. Tier 2 and Tier 3 represent intermediate levels of implementation between Tier 1 and E3. Each tier has associated with it a given nitrogen, phosphorus and sediment load reduction effected by the different technologies assigned to the tier. The nutrient and sediment sources were divided into the following categories for tier development:

- Point Sources
- Non-point Source Agriculture
- Non-point Source Urban
- Non-point Source Forests
- On-site Treatment Systems
- Atmospheric Deposition

The series of ranging scenarios were simulated by the Bay Program's Phase 4.3 Watershed Model and the resultant loads for nitrogen, phosphorus, and sediment were used as inputs to the Chesapeake Bay Estuary Model. Evaluation of clarity and DO and chlorophyll *a* concentrations from the Estuary Model, in turn, provided a sense of the response of key water quality parameters to the various loading levels. For the tier and E3 scenarios, BMP implementation levels, the resultant modeled loads, and the measured responses in tidal water quality are informational. They are not intended to prescribe control measures the jurisdictions must implement to meet *Chesapeake 2000* nutrient and sediment loading caps.

The costs for specific management practices developed by the UAA workgroup could be employed by Bay basin jurisdictions for their individual UAAs. The WQSC of the Chesapeake Bay Program believed it would be useful to provide data to the jurisdictions to promote coordination and consistency across all jurisdictions. It is a jurisdiction's prerogative to use the basin-wide costing analyses in developing their UAA.

Implementation levels in all of the tiers and E3 are not the most cost effective. More cost effective combinations of BMPs will be evaluated by jurisdictions and their tributary or watershed teams as their strategies are developed. In addition, levels of BMP implementation for E3 are theoretical since the scenario, generally, did not account for physical limitations or participation levels in its design.

The tiers and E3 BMP implementation levels were mostly deliberated and set by the "source" workgroups of the Bay Program's Nutrient Subcommittee. These workgroups are made up of representatives of Bay-watershed jurisdictions and Bay Program office personnel. The specific workgroups that decided BMP implementation levels included the Agricultural Nutrient Reduction Workgroup, the Forestry Workgroup, the Point Source Workgroup, and the Urban Stormwater Workgroup. The Tributary Strategy Workgroup (TSWG) and Nutrient Subcommittee finalized E3 definitions after review and further deliberation.

To conform to *Chesapeake 2000* goals, all of the scenarios were rooted in 2010 projections of landuses, animals, point source flows, and septic systems as well as 2007/2010 or 2020 air emission controls. Landuses and animal populations in the Chesapeake Bay Program Watershed Model are developed from an array of national, regional, and state databases as described in *Chesapeake Bay Watershed Model Land Use and Model Linkages to the Airshed and Estuarine Models* (CBPO, 2000). The modeled landuses include the following categories:

- Forest
- Conventional-Tilled (High-Till)
- Conservation-Tilled (Low-Till)
- Hay
- Pasture
- Manure Acres (model accounting of runoff from animal feeding operations)
- Pervious Urban
- Impervious Urban
- Mixed Open

2010 agricultural landuses were projected from Agricultural Census information (1982, 1987, 1992, and 1997) by county and according to methodologies chosen by individual states. Projected animal populations, to estimate manure applications, were rooted in county Agricultural Census trends and information from state environmental and agricultural agencies.

2010 urban landuses were mostly projected from a methodology involving human population changes as determined by the U.S. Census Bureau for 1990 and 2000 and by individual state agencies for 2010. The population changes were related to 1990 high-resolution satellite imagery of the Chesapeake Bay watershed which is the root source of urban and forest acreage. In the case of Maryland, urban growth from 2000 to 2010 was determined by Maryland Department of Natural Resources and the Department of Planning.

For all jurisdictions except Maryland and Virginia, 2010 forest and mixed open landuses were determined by proportioning the net change between 2010 and 1990 agricultural and urban land to 1990 mixed open and 1990 forest. Maryland and Virginia forest acreage changes followed methodologies or data submitted by these states.

Estimates of the number of septic systems in the watershed in 2010 were derived from human population projections and people per septic system ratios from the 1990 U.S. Census Bureau survey.

Point sources were divided into categories which included 1) Significant municipal wastewater treatment facilities—generally discharging flows greater than or equal to 0.5 million gallon per day, 2) Significant industrial facilities—discharging nutrient loads of greater than or equivalent to municipal facilities with flows greater than or equal to 0.5 million gallon per day, and 3) Non-significant municipal wastewater treatment facilities—discharging flows less than 0.5 million gallon per day and limited to facilities in MD and VA due to availability of data.

Point source nitrogen and phosphorus loads from significant and non-significant municipal wastewater treatment facilities were determined using flows projected for the year 2010 for POTWs located in all jurisdictions of the Chesapeake Bay Watershed. These future flows were developed either from population projections or information obtained directly from the municipal facility operators. Tier and E3 flows for industrial dischargers remained at 2000 levels because industrial flows are not necessarily subject to growth due to population.

Technologies in municipal facilities varied among the tiers depending on the nutrient concentrations to be achieved under each tier description. The technologies included extended aeration processes and denitrification zones, chemical additions, additional clarification tanks, deep bed denitrification filters, and micro-filtration. For industrial dischargers, site-specific information on reductions by facility was obtained via phone contacts or site visits.

Atmospheric deposition to the Bay catchment for all tier and E3 scenarios employed deposition data from the Regional Acid Deposition Model (RADM) developed in Research Triangle Park, NC, which also provides deposition estimates representing current conditions used for Progress model runs. All of the air scenarios involve nitrogen oxide emissions reductions made by roughly 37 states (the deposition modeling domain). Air scenarios in Tiers 1 and 2 describe existing Clean Air Act regulations that have passed. Tier 3 and E3 describe additional voluntary control measures.

1. 2010 TIER 1 SCENARIO

2010 Tier 1 BMP implementation levels were generally determined by continuing current levels of effort and cost-share in the Bay catchment. In addition, expected regulatory measures, jurisdictional programs, and construction schedules between 2000 and 2010 were included.

1.1 2010 Tier 1 Non-Point Source BMPs

For most non-point source BMPs, implementation rates between 1997 and 2000 were continued to the year 2010 with limits that levels could not exceed the available or E3 land area to apply the BMPs to. The scale of the calculations was a county-segment or the intersection of a county political boundary and a model hydrologic segment. This is the same scale that most jurisdictions report BMP implementation levels to the Bay Program office.

Every effort was made to include BMPs submitted by the jurisdictions for progress model runs into Tier 1. Since historic BMP data was not available from NY, DE, and WV, 2010 Tier 1 projections were determined from watershed-wide implementation rates in states which employ and track the practice.

2010 Tier 1 BMPs were extrapolated from recent implementation rates by the landuse types submitted by the states for each BMP. For example, if a jurisdiction submits data for nutrient management on crop, 2010 Tier 1 crop was projected and then split among high-till, low-till, and hay according to relative percentages. If a jurisdiction submits data as nutrient management on high-till, low-till, and hay individually, projections were done for each of these landuse categories.

The 2010 Tier 1 scenario does not include tree planting on tilled land, forest conservation, and forest harvesting practices as these BMPs are not part of the tiers and E3. For forest harvesting practices and erosion and sediment control, the model simulation does not account for additional loads from disturbed forest and construction areas, respectively. For forest conservation, planting above what is removed during development is accounted for in the 2010 urban and forest projections. Tree planting on agricultural land was included in Tier 1 for pasture as forest buffers since this BMP is also part of the tiers and E3 and pasture tree planting and pasture buffers are treated the same in the model.

1.2 2010 Tier 1 Agricultural BMPs

- Tier 1 Conservation tillage
  - Continue 1997–2000 implementation rates of conservation-tillage.
  - Low-till acres cannot be below 2000 levels or greater than 75% of the available cropland by county-segment.
  - Landuse conversion of high-till to low-till.
- Tier 1 Riparian forest buffers on agriculture

- Continue 1997–2000 implementation rates of riparian forest buffers on cropland and hay to the year 2010.
- Continue 1997–2000 implementation rates of tree planting on pasture to the year 2010.
- Tier 1 implementation levels cannot exceed the available or E3 land area to apply the BMP to.
- E3 assumes 100-foot forest buffers on un-buffered stream miles (each side) associated with crop, hay, and pasture.
- Landuse conversion of crop, hay, and pasture to forest.
- For every acre of crop and hay converted, two upland acres of crop and hay receive a reduction of 57% (TN), 70% (TP), and 70% (SED).
  –There is no upland benefit associated with forest buffers on pasture.

C Tier 1 Wetland restoration
- Continue 1997–2000 implementation rates of wetland restoration on cropland and hay to the year 2010.
- Landuse conversion of crop and hay to forest.

C Tier 1 Agricultural land retirement
- Continue 1997–2000 implementation rates of cropland and hay retirement to the year 2010.
- The sum of the acreage in Tier 1 riparian forest buffers, wetland restoration, and land retirement cannot exceed 25% of the total crop and hay in a county-segment.
- Landuse conversions of crop and hay to mixed open.

C Tier 1 Riparian grass buffers on cropland
- Continue 1997–2000 implementation rates of riparian grass buffers on cropland to the year 2010 with limits that levels cannot exceed the available or E3 land area to apply the BMPs to.
- E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
- E3 assumes 100-foot buffers on un-buffered stream miles (each side) associated with agricultural land.
- Landuse conversions of crop to mixed open.
- For every acre of cropland converted, two upland acres of crop receive a reduction of 43% (TN), 53% (TP), and 53% (SED).

C Tier 1 Nutrient Management Plan Implementation
- Continue 1997–2000 rates of nutrient management plan implementation on crop and hay to the year 2010 in all jurisdictions except MD and DE where all crop and hay acres are fully implementing nutrient management plans.
- Nutrient management plan implementation levels cannot exceed the available land area to apply the BMPs to.
- Under nutrient management plans, crop and hay acres do not receive more than 130% of their TN and TP need.

C Tier 1 Manure excess
- Excess nutrients resulting from the differences between manure generated and conforming to nutrient management rules and losses in agricultural land are reported.
- It is assumed that all of the excess manure has alternative uses that do not affect loads to the Chesapeake Bay.

- Tier 1 Animal waste management/runoff control
  - Continue 1997–2000 implementation rates of animal waste management on "manure acres" to the year 2010 with limits that levels cannot exceed the available area to apply the BMPs to.
  - Manure acres are the model's accounting of runoff from animal feeding operations based on the number of animal units.
  - The BMP combines storage systems and barnyard runoff controls and reduction factors of 75% (TN and TP) are applied to protected manure acres.
- Tier 1 Farm Plans (non-nutrient management)
  - Continue 1997–2000 rates of Farm Plan implementation on agricultural land (crop, hay, and pasture) to the year 2010 with limits that levels cannot exceed the available land area to apply the BMPs to.
  - Nutrient and sediment reduction factors for Farm Plans on high-till are 10% (TN) and 40% (TP and SED). Low-till and hay reduction factors are 4% (TN) and 8% (TP and SED) while the reduction factors for Farm Plans on pasture are 20% (TN) and 14% (TP and SED).
- Tier 1 Cover crops
  - Since cover crop acreage varies annually or is not cumulative, cover crop implementation is determined as the average of 1997–2000 implementation acreage (or years in that period where data exists from the jurisdictions) with limits that levels cannot exceed the available land area to apply the BMPs to.
  - BMP reduction factors of 35% (TN) and 15% (TP and SED) are applied to cover crop acres.
- Tier 1 Streambank protection with fencing
  - Continue 1997–2000 implementation rates of streambank protection with fencing on pasture to the year 2010 with limits that levels cannot exceed the available of E3 land area to apply the BMPs to.
  - E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
  - E3 assumes for every stream mile protected, 51 upland acres of pasture receive a reduction benefit.
  - BMP reduction factors of 75% for TN, TP, and SED are applied to pasture acres protected.
- Tier 1 Streambank protection without fencing
  - Continue 1997–2000 implementation rates of streambank protection without fencing on pasture to the year 2010 with limits that levels cannot exceed the available pasture land area to apply the BMPs to.
  - BMP reduction factors of 40% for TN, TP, and SED are applied to pasture acres protected.
- Tier 1 Grazing land protection
  - Continue 1997–2000 implementation rates of rotational grazing on pasture to the year 2010 with limits that levels cannot exceed the available land area to apply the BMPs to.
  - BMP reduction factors of 50% (TN) and 25% (TP) are applied to protected pasture acres.

1.3 2010 Tier 1 Urban and Mixed Open BMPs

- Tier 1 Environmental site design/low-impact development on new development
  - Environmental site design/low-impact development practices applied to 66% of new development between 2000 and 2010.
  - Environmental site design and low-impact development practices are designed to reduce TN by 35%, TP by 45%, and SED by 80%.
- Tier 1 Stormwater retrofits on recent development
  - 60% of recent development (1986–2000) is retrofitted with a suite of practices to reduce nutrients and sediment in stormwater runoff by 20% (TN), 30% (TP), and 65% (SED).
- Tier 1 Stormwater retrofits on old and recent development
  - 0.8% of pre-1986 urban land and 1986–2000 recent development has stormwater management practices that reduce nutrients and sediment in runoff by 20% (TN), 30% (TP), and 65% (SED).
- Tier 1 Riparian forest and grass buffers on urban
  - It is assumed that all urban stream reaches have either forest or grass riparian buffers except where urban disturbance has altered a stream reach beyond repair/restoration (i.e., impervious surface).
  - 50-foot buffers on all un-buffered stream miles (each side) associated with pervious urban.
  - Landuse conversion of pervious urban to mixed open (grass buffers) or forest (forest buffers).
  - There is no upland benefit associated with forest and grass buffers on urban.
- Tier 1 Riparian forest buffers on mixed open
  - Continue 1997–2000 implementation rates of tree planting on mixed open to the year 2010 with limits that levels can not exceed the available or E3 land area to apply the BMPs to.
  - 100-foot forest buffers on all un-buffered stream miles (each side) associated with mixed open.
  - Landuse conversion of mixed open to forest.
  - There is no upland benefit associated with forest buffers on mixed open.
- Tier 1 Nutrient management on urban and mixed open
  - Continue 1997–2000 implementation rates of nutrient management on pervious urban and mixed open to the year 2010 with limits that levels cannot exceed the available land area to apply the BMPs to.
  - BMP reduction factors of 17% (TN) and 22% (TP) are applied to acres under nutrient management.

1.4 2010 Tier 1 Forest Harvest BMPs

- It is assumed that forestry BMPs designed to minimize the environmental impacts from timber harvesting , such as road building and cutting/thinning operations, are properly

installed on all harvested lands with no measurable increase in nutrient and sediment discharge.

- The assumption is based on maintaining the state of forest loads as measured during the calibration of the Bay Program Watershed Model.

1.5 2010 Tier 1 Septic BMPs

- Current edge-of-septic-field concentrations and flows per system are maintained.
- The number of systems varies according to population projections from 2000 to 2010.
- Septic BMPs incorporate submissions from the Bay-basin jurisdictions of the current number of systems employing denitrification technologies (50% TN reduction) and those with regular maintenance through pumping (5% TN reduction).

1.6 2010 Tier 1 Point Source BMPs

- Tier 1 Significant municipal wastewater treatment facilities
  - Nitrogen – POTWs with existing nutrient-removal technologies (NRT) and those planned to go to NRT by 2010 are at 2010 projected flows and 8 mg TN/l effluent concentrations (annual average). All remaining significant facilities are at 2010 projected flows and 2000 TN effluent concentrations.
  - Phosphorus – 2010 projected flows and 2000 TP/l effluent concentrations except those targeted in VA which are at 1.5 mg TP/l (annual average).
- Tier 1 Significant industrial dischargers
  - 2000 flows and maintain current (2000) levels of effluent concentrations for TN and TP or the permit limit, whichever is less.
- Tier 1 Non-significant municipal wastewater treatment facilities
  - 2000 TN and TP effluent concentrations applied to 2010 projected flows.

1.7 2010 Tier 1 Combined Sewer Overflow BMPs

- There is a 43% reduction in the current discharge from DC combined sewer overflows, the only CSO loads among all jurisdictions for which the Bay Program has nutrient load data specifically quantified in the model simulation.
- The reduction from 2000 loads is what is expected by the District to be achieved by 2010.

1.8 2010 Tier 1 Atmospheric Deposition BMPs

Tier 1 atmospheric deposition assumes implementation of the 1990 Clean Air Act projected for the year 2010 with nitrogen oxide emissions regulations for ground-level ozone and acid rain that have passed. Estimated changes in deposition for the Tier 1 scenario includes the following controls on nitrogen oxide emissions:

- 2007 non-utility (industrial) point source and area source emissions.
- 2007 mobile source emissions with “Tier II” tail pipe standards on light duty vehicles.

- 2010 utility emissions with Title IV (Acid Rain Program) fully implemented and 20-state NOx SIP call reductions at 0.15 lbs/MMbtu during the May to September ozone season only.

The impacts of Tier 1 emissions and deposition to the Bay watershed's land area and non-tidal waters are part of the reported nutrient loads from the individual landuse source categories, i.e., agriculture, urban, mixed open, forest, and non-tidal surface waters). The reported Watershed Model loads; however, usually do not include contributions from atmospheric deposition to tidal waters although the water quality responses, as measured by the Estuary Model, account for this source at levels prescribed by Tier 1.

1.9 2010 Tier 1 Shoreline Erosion BMPs

- Tier 1 shoreline erosion controls include structural and non-structural practices at 2000 levels.

The impacts of Tier 1 shoreline erosion controls are not included in the reported Watershed Model loads although the water quality responses, as measured by the Estuary Model, account for this source at BMP levels prescribed by Tier 1.

2. 2010 E3 SCENARIO

BMP implementation levels in the tier scenarios were bounded by levels of E3. E3 was specifically designed to take out most of the subjectivity surrounding what can or cannot be achieved in control measures.

The particular definitions of E3 BMP implementation levels were, in part, rooted in earlier work of the Bay Program when a "limit-of-technology" condition was assessed by the TSWG. However, E3 is less subjective than the limit-of-technology scenarios in its determinations of maximum implementation levels.

The BMP levels in E3 are theoretical. There are no cost and few included physical limitations to implementing BMPs for point and non-point sources. In addition, E3 includes new BMP technologies and programs that are not currently part of jurisdictional pollutant control strategies.

For most non-point source BMPs, it was assumed that the load from every available acre of the relevant land area was being controlled by a full suite of existing or innovative practices. In addition, management programs converted landuses from those with high-yielding nutrient and sediment loads to those with lower.

For point sources in E3, municipal wastewater treatment facilities reach and maintain effluent concentrations of 3 mg TN/l and at least 0.1 mg TP/l through technologies such as deep bed denitrification filters and micro-filtration.

E3 implementation levels and their associated reductions in nutrients and sediment were developed without consideration of site specific physical constraints, costs, or even plausible BMP program participation levels. The Chesapeake Bay Program acknowledges that if these factors are considered, several aspects of E3 could not be achieved.

On the other hand, there are some control measures in E3 that physically could be more aggressive. The E3 conditions for these BMPs were established because a theoretical maximum implementation level would have been entirely subjective.

BMP implementation levels for the E3 scenario are described in detail below for the major source categories—agriculture, urban and mixed open, point sources, septic, and atmospheric deposition.

2.1 Physical Limitations to E3

In all appropriate circumstances, BMP implementation levels in the E3 scenario were applied to all relevant landuse areas or current limits-of-technology. In many cases and to remove the subjectivity in determining human-caused conditions that cannot be remedied, there were no physical limitations to employing the practices or programs.

For many BMPs, the E3 implementation levels could not be physically achieved. For example, space may not be available for 50-foot riparian buffers in urban areas or certain developed lands may not allow for retrofitting with practices that attain pollutant reduction efficiencies used in E3. As other examples, certain crop types cannot be conservation-tilled and it may be physically impossible to completely eliminate runoff from animal feeding operations.

It is also unlikely that every homeowner and farmer would efficiently apply fertilizers so that only the needs of the vegetation are met and that water-front property owners would plant 50-foot buffers even if it were physically possible. As a whole, "feasible" participation levels are not built into E3. All of the above-mentioned instances are examples of where E3 may overestimate reductions.

2.2 Underestimations of Load Reductions of E3

Contrarily, there are assumptions in the E3 scenario where BMP implementation levels could physically be even higher than those currently defined in E3. For example, it is physically possible that more than 25,000 acres of cropland and hay in Chesapeake Bay watershed could be restored to wetlands. This limit on wetland acres restored in the E3 scenario in Pennsylvania, Maryland and Virginia was used to reflect the *Chesapeake 2000* goal since a theoretical maximum implementation level for wetlands restoration would be entirely subjective.

As an other example, 25% of cropland was replaced with long-term grasses that serve as a carbon bank and could be converted to energy through combustion. Benefits of a carbon sequestration program, in terms of lower pollutant loads, would increase as more agricultural land is converted. Conversion of more than 25% of cropland is physically possible. In addition, the 30 percent reduction in urban sprawl over a decade could be physically set at a higher level. This rate was employed in the E3 scenario to adhere to a *Chesapeake 2000* goal.

The E3 scenario only includes shoreline erosion controls at current levels for lack of a "maximum" limit that would not be entirely subjective. It has been demonstrated through modeling efforts that additional controls of shoreline erosion can significantly improve tidal water quality. In general, much opportunity exists for reducing sediment and nutrient loads from eroding shorelines that would not be reflected in E3 scenario water quality model results.

If greater BMP implementation levels than those designated in E3 could be physically achieved for any BMPs, pollutant loadings would decrease and the there would be corresponding improved responses in water quality. For the most part, however, E3 did not consider real physical limitations to BMP implementation or participation levels.

2.3 2010 E3 Agricultural BMPs

- E3 Conservation tillage
  - All cropland (high-till and low-till) is conservation-tilled
  - Landuse conversion of high-till to low-till.
- E3 Riparian forest buffers on agriculture

  - 100-foot forest buffers on all un-buffered stream miles (each side) associated with crop, hay, and pasture.
  - Landuse conversion of low-till, hay, and pasture to forest.
  - For every acre of low-till and hay converted, two upland acres of low-till and hay receive a reduction of 57% (TN), 70% (TP), and 70% (SED).
  - There is no upland benefit associated with forest buffers on pasture.
- E3 Wetland restoration
  - In accordance with the *Chesapeake 2000* agreement, 25,000 acres of crop and hay in PA, MD, and VA are converted to and simulated as forest.
  - The 25,000 acre restoration goal is allocated among these states as follows to conform to agreements subsequent to C2K: PA = 4,250 acres, MD = 15,000 acres, and VA = 5,750 acres.
- E3 Agricultural land retirement
  - The remainder of 25% of the total crop and hay acres and those acres converted through forest buffers and wetland restoration is retired to a grass condition.
  - Landuse conversions of low-till and hay to mixed open.
- E3 Carbon sequestration/bio-energy
  - 25% of crop acres (after BMP landuse conversions) are replaced with long-term grasses that serve as a carbon bank and could be converted to energy through combustion.
  - Landuse conversion of low-till to hay.
- E3 Yield reserve program
  - All crop and hay acres (after BMP landuse conversions) receive 25% less TN and TP than normal nutrient management applications - Do not receive more than 98% of TN and TP need.
  - Yield reserve program assumes farmer insurance for yield losses.
- E3 Manure excess
  - Excess nutrients resulting from the differences between manure generated and conforming to yield reserve (nutrient management) rules and losses in agricultural land are reported.
  - It is assumed that all of the excess manure has alternative uses that do not affect loads to the Chesapeake Bay.
- E3 Animal waste management/runoff control
  - There is no runoff from manure in animal feeding operations.
  - Modeled landuse acres that account for runoff from animal feeding operations are converted to pasture.
  - Landuse conversion of manure acres to pasture.
- E3 Farm Plans (non-nutrient management)
  - Farm Plans are fully implemented on all agricultural land (crop, hay, and pasture).
  - Nutrient and sediment reduction factors for Farm Plans on low-till and hay are 4% (TN) and 8% (TP and SED). Pasture reduction factors are 20% (TN) and 14% (TP and SED).
- E3 Cover crops
  - All crop landuses have cover crops.
  - BMP reduction factors of 35% (TN) and 15% (TP and SED) are applied to all low-till.

- E3 Streambank protection with fencing
  - Streambank protection with fencing on all unprotected stream miles (each side) associated with pasture.
  - For every stream mile protected, 51 upland acres of pasture receive a reduction of 75% for TN, TP and SED.
- E3 Grazing land protection
  - All pasture land is protected through rotational grazing.
  - BMP reduction factors of 50% (TN) and 25% (TP) are applied.

2.4 2010 E3 Urban and Mixed Open BMPs

- E3 Reduction in 2000–2010 urban growth
  - 30% of the projected pervious and impervious urban growth in PA, MD, VA, and DC between 2000 and 2010 remains in forest to conform to the Chesapeake 2000 agreement.
  - It is assumed that the reduction in projected urban growth in PA, MD, VA, and DC over the decade is retained or planted in forest.
  - Landuse conversions of pervious and impervious urban to forest.
- E3 Environmental site design/low-impact development on new development
  - Environmental site design/low-impact development practices applied to all urban growth between 2000 and 2010.
  - Environmental site design and low-impact development practices are designed to reduce TN by 50%, TP by 60%, and SED by 90%.
- E3 Stormwater retrofits on existing urban
  - All pre-2001 urban areas are retrofitted with a suite of practices to reduce nutrients and sediment in stormwater runoff by 40% (TN), 40% (TP), and 80% (SED).
- E3 Riparian forest buffers on urban
  - 50-foot forest buffers on all un-buffered stream miles (each side) associated with pervious urban.
  - Landuse conversion of pervious urban to forest.
  - There is no upland benefit associated with forest buffers on urban.
- E3 Riparian forest buffers on mixed open
  - 100-foot forest buffers on all un-buffered stream miles (each side) associated with mixed open.
  - Landuse conversion of mixed open to forest.
  - There is no upland benefit associated with forest buffers on mixed open.
- E3 Nutrient management on urban and mixed open
  - All pervious urban and mixed open acres do not receive nutrient applications from chemical fertilizers.

2.5 2010 E3 Forest Harvest BMPs

- It is assumed that forestry BMPs designed to minimize the environmental impacts from timber harvesting , such as road building and cutting/thinning operations, are properly

installed on all harvested lands with no measurable increase in nutrient and sediment discharge.

- The assumption is based on maintaining the state of forest loads as measured during the calibration of the Bay Program Watershed Model.

2.6 2010 E3 Septic BMPs

- All septic systems employ denitrification technologies and are maintained through regular pumping to meet an edge-of-septic-field TN concentration of 10 mg/L or 2.3 lbs TN per person-year.

2.7 2010 E3 Point Source BMPs

- E3 Significant municipal wastewater treatment facilities
  - Nitrogen –POTWs are at 2010 projected flows and reach and maintain effluent concentrations of 3 mg TN/l (annual average).
  - Phosphorus –POTWs are at 2010 projected flows and reach and maintain effluent concentrations of 0.1 mg TP/l (annual average).
- E3 Significant industrial dischargers
  - Nitrogen – 2000 flows and effluent concentrations of 3 mg TN/l (annual average).
  - Phosphorus – 2000 flows and effluent concentrations of 0.1 mg TP/l (annual average) or the permit limit, whichever is less.
- E3 Non-significant municipal wastewater treatment facilities
  - Nitrogen – POTWs are at 2010 projected flows and reach and maintain effluent concentrations of 8 mg TN/l (annual average).
  - Phosphorus –POTWs are at 2010 projected flows and reach and maintain effluent concentrations of 2.0 mg TP/l (annual average) or 2000 concentrations, whichever is less.

2.8 2010 E3 Combined Sewer Overflow BMPs

- There is no discharge from DC combined sewer overflows, the only CSO loads among all jurisdictions for which the Bay Program has nutrient load data specifically quantified in the model simulation.

2.9 2010 E3 Atmospheric Deposition BMPs

E3 atmospheric deposition assumes existing regulatory nitrogen oxide emissions controls under the 1990 Clean Air Act, as well as more aggressive but voluntary emissions controls on the utility, industrial, and mobile source sectors, projected for the year 2020. Estimated changes in deposition for the E3 scenario includes the following controls on nitrogen oxide emissions:

- 2020 non-utility (industrial) point source emissions cut almost in half for both SO2 and NOx.

- 2020 area source emissions that are the same as Tiers 1-3.
- 2020 mobile source emissions assuming super ultra-low emissions for light duty vehicles and heavy duty diesel standards to further reduce NOx emission beyond Tier 2 and Tier 3.
- 2020 utility emissions with major (90%) reductions in SO2 and aggressive 20-state NOx SIP call reductions through utilities going to 0.10 lbs/MMbtu for the entire year—same as Tier 3 controls.

The impacts of E3 emissions and deposition to the Bay watershed's land area and non-tidal waters are part of the reported nutrient loads from the individual landuse source categories, i.e., agriculture, urban, mixed open, forest, and non-tidal surface waters). The reported Watershed Model loads; however, usually do not include contributions from atmospheric deposition to tidal waters although the water quality responses, as measured by the Estuary Model, account for this source at levels prescribed by E3.

2.10 2010 E3 Shoreline Erosion BMPs

- E3 shoreline erosion controls include structural and non-structural practices at 2000 levels.

The impacts of E3 shoreline erosion controls are not included in the reported Watershed Model loads although the water quality responses, as measured by the Estuary Model, account for this source at BMP levels prescribed by E3.

3. 2010 TIER 2 SCENARIO

2010 Tier 2 BMP implementation levels for non-point sources were generally determined by increasing levels above Tier 1 by a percentage of the difference between Tier 1 and E3 levels for each BMP. These percentages were mostly recommended by individual source workgroups in the Bay Program Nutrient Subcommittee and were applied watershed-wide by county-segments or the intersections of county political boundaries and the Watershed Model's hydrologic segmentation.

For Tier 2 point source municipal facilities, technologies to achieve 8 mg TN/l included extended aeration processes and denitrification zones, along with chemical addition to achieve a phosphorus discharge of 1.0 mg/l where facilities are not already achieving these levels.

In the design of the Tier 2 scenario, considerations of the costs of BMP implementation, participation levels, and physical limitations are very limited. Tier 2 BMP levels are considered technically possible and are listed below for each of the major source categories.

3.1 2010 Tier 2 Agricultural BMPs

- Tier 2 Conservation tillage
  - Applied to "Tier 1" levels plus 30% of the of the available crop acres between "Tier 1" and "E3" levels.
  - Tier 1 and E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
  - Landuse conversion of high-till to low-till.
- Tier 2 Riparian forest buffers on agriculture
  - Applied to "Tier 1" levels plus 20% of the of the available stream reaches in cropland and pasture and 25% of the remaining stream reaches in hay between "Tier 1" and "E3" levels.
  - Tier 1 and E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
  - E3 assumes 100-foot forest buffers on un-buffered stream miles (each side) associated with crop, hay, and pasture.
  - Tier 1 forest buffers on pasture are rooted in agricultural tree planting from jurisdictional BMP reporting.
  - Landuse conversions of crop, hay, and pasture to forest.
  - For every acre of crop and hay converted, two upland acres of crop and hay receive a reduction of 57% (TN), 70% (TP), and 70% (SED).
  - There is no upland benefit associated with forest buffers on pasture.
- Tier 2 Wetland restoration
  - Applied to "Tier 1" levels plus 33% of the of the available crop and hay acres in PA, MD, and VA between "Tier 1" and "E3" levels.
  - Tier 1 and E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
  - Landuse conversion of crop and hay to forest.

- Tier 2 Agricultural land retirement
  - The remainder of 10% of the total crop and hay acres and those acres converted through forest buffers and wetland restoration is retired to a grass condition.
  - Landuse conversions of crop and hay to mixed open.
- Tier 2 Riparian grass buffers on cropland
  - Applied to "Tier 1" levels plus 25% of the of the available stream reaches in cropland between "Tier 1" and "E3" levels and after forest buffer planting.
  - Tier 1 and E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
  - E3 assumes 100-foot buffers on un-buffered stream miles (each side) associated with agricultural land.
  - Landuse conversions of crop to mixed open.
  - For every acre of cropland converted, two upland acres of crop receive a reduction of 43% (TN), 53% (TP), and 53% (SED).
- Tier 2 Nutrient Management Plan Implementation
  - Applied to "Tier 1" levels plus 30% of the of the available crop and hay acres between "Tier 1" and "E3" levels in PA, VA, NY, and WV.
  - All crop and hay acres in MD and DE are fully implementing nutrient management plans.
  - Tier 1 and E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
  - Under nutrient management plans, crop and hay acres do not receive more than 130% of their TN and TP need.
- Tier 2 Manure excess
  - Excess nutrients resulting from the differences between manure generated and conforming to nutrient management rules and losses in agricultural land are reported.
  - It is assumed that all of the excess manure has alternative uses that do not affect loads to the Chesapeake Bay.
- Tier 2 Animal waste management/runoff control
  - Applied to "Tier 1" levels plus 25% of the of the available manure acres between "Tier 1" and "E3" levels.
  - Tier 1 ands E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
  - BMP reduction factors of 75% (TN and TP) are applied to protected manure acres.
- Tier 2 Farm Plans (non-nutrient management)
  - Applied to "Tier 1" levels plus 30% of the of the available agricultural acres (crop, hay, and pasture) between "Tier 1" and "E3" levels.
  - Tier 1 and E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
  - Nutrient and sediment reduction factors for Farm Plans on high-till are 10% (TN) and 40% (TP and SED). Low-till and hay reduction factors are 4% (TN) and 8% (TP and SED) while the reduction factors for Farm Plans on pasture are 20% (TN) and 14% (TP and SED).

- Tier 2 Cover crops
  - Applied to "Tier 1" levels plus 40% of the of the available cropland between "Tier 1" and "E3" levels.
  - Tier 1 and E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
  - BMP reduction factors of 35% (TN) and 15% (TP and SED) are applied to cover crop acres.
- Tier 2 Streambank protection with fencing
  - Applied to "Tier 1" levels plus 15% of the of the available pasture land that can be protected between "Tier 1" and "E3" levels.
  - Tier 1 ands E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
  - BMP reduction factors of 75% for TN, TP, and SED are applied to pasture acres protected.
- Tier 2 Streambank protection without fencing
  - Applied to "Tier 1" levels plus 10% of the available pasture land area to apply the BMPs to accounting for the acres protected by fencing.
  - Tier 1 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes and streambank protection with fencing.
  - BMP reduction factors of 40% for TN, TP, and SED are applied to pasture acres protected.
- Tier 2 Grazing land protection
  - Applied to "Tier 1" levels plus 25% of the of the available pasture land between "Tier 1" and "E3" levels.
  - Tier 1 ands E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
  - BMP reduction factors of 50% (TN) and 25% (TP) are applied to protected pasture acres.

3.2 2010 Tier 2 Urban and Mixed Open BMPs

- Tier 2 Reduction in 2000–2010 urban growth
  - 10% of the projected pervious and impervious urban growth in PA, MD, VA, and DC between 2000 and 2010 is not developed.
  - It is assumed that 65% of the reduction in projected urban growth is retained in forest, 20% in mixed open, and 15% in agriculture.
  - Landuse conversions of pervious and impervious urban to forest, mixed open, and agriculture (crop, hay, and pasture).
- Tier 2 Environmental site design/low-impact development on new development
  - Environmental site design/low-impact development practices applied to all new development between 2000 and 2010.
  - Environmental site design and low-impact development practices are designed to reduce TN by 40%, TP by 55%, and SED by 85%.
- Tier 2 Stormwater retrofits on recent development

  - 60% of recent development (1986–2000) is retrofitted with a suite of practices to reduce nutrients and sediment in stormwater runoff by 20% (TN), 30% (TP), and 65% (SED).
- Tier 2 Stormwater retrofits on old and recent development
  - 5% of pre-1986 urban land and 1986–2000 recent development has stormwater management practices that reduce nutrients and sediment in runoff by 20% (TN), 30% (TP), and 65% (SED).
- Tier 2 Riparian grass buffers on urban
  - Urban grass buffer acreage is reduced 10% below "Tier 1"levels and is converted to urban forest buffers.
  - Tier 1 levels are revised following the same methodology but account for previously applied BMPs that involve landuse changes.
  - The assumption is maintained that all urban stream reaches have 50-foot riparian buffers in either forest or grass except where urban disturbance has altered a stream reach beyond repair/restoration (i.e., impervious surface).
  - There is no upland benefit associated with grass buffers on urban.
- Tier 2 Riparian forest buffers on urban
  - Urban forest buffer acreage is increased by the same amount as the reduction in urban grass buffers.
  - The assumption is maintained that all urban stream reaches have 50-foot riparian buffers in either forest or grass except where urban disturbance has altered a stream reach beyond repair/restoration (i.e., impervious surface).
  - There is no upland benefit associated with forest buffers on urban.
- Tier 2 Riparian forest buffers on mixed open
  - Mixed open forest buffer acreage is increased from "Tier 1" levels by the same amount as the increase in urban forest buffers between "Tier 1" and Tier 2.
  - Tier 1 levels are revised following the same methodology but account for previously applied BMPs that involve landuse changes.
  - Landuse conversion of mixed open to forest.
  - There is no upland benefit associated with forest buffers on mixed open.
- Tier 2 Nutrient management on urban and mixed open
  - It is assumed that 40% of pervious urban and 40% of mixed open land are under nutrient management.
  - BMP reduction factors of 17% (TN) and 22% (TP) are applied to acres under nutrient management.

3.3 2010 Tier 2 Forest Harvest BMPs

- It is assumed that forestry BMPs designed to minimize the environmental impacts from timber harvesting, such as road building and cutting/thinning operations, are properly installed on all harvested lands with no measurable increase in nutrient and sediment discharge.
- The assumption is based on maintaining the state of forest loads as measured during the calibration of the Bay Program Watershed Model.

3.4 2010 Tier 2 Septic BMPs

- 10% of new treatment systems between 2000 and 2010 employ denitrification technologies and are maintained through regular pumping to meet an edge-of-septic-field TN concentration of 10 mg/L or 2.3 lbs TN per person-year.
- Remaining new and existing systems are at current edge-of-septic-field concentrations and flows per system.
- Septic BMPs incorporate submissions from the Bay-basin jurisdictions of the current number of systems employing denitrification technologies (50% TN reduction) and those with regular maintenance through pumping (5% TN reduction).

3.5 2010 Tier 2 Point Source BMPs

- Tier 2 Significant municipal wastewater treatment facilities
  - Nitrogen – All significant POTWs are at 2010 projected flows and reach and maintain effluent concentrations of 8 mg TN/l (annual average) including those facilities that planned to go to NRT by 2010.
  - Phosphorus – POTWs are at 2010 projected flows and reach and maintain effluent concentrations of 1.0 mg TP/l (annual average) or the permit limit, whichever is less.
- Tier 2 Significant industrial dischargers
  - 2000 flows and generally maintain effluent concentrations that are 50% less that those in Tier 1 or the permit limit, whichever is less.
- Tier 2 Non-significant municipal wastewater treatment facilities
  - 2000 TN and TP effluent concentrations applied to 2010 projected flows.

3.6 2010 Tier 2 Combined Sewer Overflow BMPs

- There is a 43% reduction in the current discharge from DC combined sewer overflows, the only CSO loads among all jurisdictions for which the Bay Program has nutrient load data specifically quantified in the model simulation.
- The reduction from 2000 loads is what is expected by the District to be achieved by 2010.

3.7 2010 Tier 2 Atmospheric Deposition BMPs

Tier 2 atmospheric deposition assumes implementation of the 1990 Clean Air Act projected for the year 2020 with nitrogen oxide emissions regulations described in Tier 1 plus heavy duty diesel regulations that have passed. Estimated changes in deposition for the Tier 2 scenario includes the following controls on nitrogen oxide emissions:

- 2020 non-utility (industrial) point source and area source emissions with no additional controls than Tier 1.
- 2020 mobile source emissions with with the effect of the Tier II tail pipe standards on light duty vehicles being felt, and the implementation of the heavy duty diesel standards to further reduce NOx emissions.

- 2020 utility emissions with Title IV (Acid Rain Program) fully implemented and 20-state NOx SIP call reductions at 0.15 lbs/MMbtu during the May to September ozone season only—Same as Tier 1 controls.

The impacts of Tier 2 emissions and deposition to the Bay watershed's land area and non-tidal waters are part of the reported nutrient loads from the individual landuse source categories, i.e., agriculture, urban, mixed open, forest, and non-tidal surface waters). The reported Watershed Model loads; however, usually do not include contributions from atmospheric deposition to tidal waters although the water quality responses, as measured by the Estuary Model, account for this source at levels prescribed by Tier 2.

3.8 2010 Tier 2 Shoreline Erosion BMPs

- Tier 2 shoreline erosion controls include structural and non-structural practices at 2000 levels.

The impacts of Tier 2 shoreline erosion controls are not included in the reported Watershed Model loads although the water quality responses, as measured by the Estuary Model, account for this source at BMP levels prescribed by Tier 2.

4. 2010 TIER 3 SCENARIO

2010 Tier 3 BMP implementation levels for non-point sources were generally determined by increasing levels above Tier 1 by a percentage of the difference between Tier 1 and E3 levels with the percentages being higher than those used in Tier 2. As with Tier 2, the levels of non-point source control were applied watershed-wide by county-segments or the intersections of county political boundaries and the Watershed Model's hydrologic segmentation.

For Tier 3 municipal point source facilities, technologies to achieve 5 mg TN/l included extended aeration processes beyond those in Tier 2, a secondary anoxic zone plus methanol addition, additional clarification tanks, and additional chemicals to achieve a phosphorus discharge of 0.5 mg TP/l.

In the Tier 3 scenario, considerations of the costs of BMP implementation, participation levels, and physical limitations are very limited. Tier 3 BMP levels are considered technically possible and are listed below for each of the major source categories.

4.1 2010 Tier 3 Agricultural BMPs

- Tier 3 Conservation tillage
  - Applied to "Tier 1" levels plus 60% of the of the available crop acres between "Tier 1" and "E3" levels.
  - Tier 1 and E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
  - Landuse conversion of high-till to low-till.
- Tier 3 Riparian forest buffers on agriculture
  - Applied to "Tier 1" levels plus 30% of the of the available stream reaches in cropland and pasture and 50% of the remaining stream reaches in hay between "Tier 1" and "E3" levels.
  - Tier 1 and E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
  - E3 assumes 100-foot forest buffers on un-buffered stream miles (each side) associated with crop, hay, and pasture.
  - Tier 1 forest buffers on pasture are rooted in agricultural tree planting from jurisdictional BMP reporting.
  - Landuse conversions of crop, hay, and pasture to forest.
  - For every acre of crop and hay converted, two upland acres of crop and hay receive a reduction of 57% (TN), 70% (TP), and 70% (SED).
  - There is no upland benefit associated with forest buffers on pasture.
- Tier 3 Wetland restoration
  - Applied to "Tier 1" levels plus 66% of the of the available crop and hay acres in PA, MD, and VA between "Tier 1" and "E3" levels.
  - Tier 1 and E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
  - Landuse conversion of crop and hay to forest.

- Tier 3 Agricultural land retirement
  - The remainder of 15% of the total crop and hay acres and those acres converted through forest buffers and wetland restoration is retired to a grass condition.
  - Landuse conversions of crop and hay to mixed open.
- Tier 3 Carbon sequestration/bio-energy
  - 15% of crop acres (after BMP landuse conversions) are replaced with long-term grasses that serve as a carbon bank and could be converted to energy through combustion.
  - Landuse conversion of low-till to hay.
- Tier 3 Riparian grass buffers on cropland
  - Applied to "Tier 1" levels plus 50% of the of the available stream reaches in cropland between "Tier 1" and "E3" levels and after forest buffer planting.
  - Tier 1 and E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
  - E3 assumes 100-foot buffers on un-buffered stream miles (each side) associated with agricultural land.
  - Landuse conversions of crop to mixed open.
  - For every acre of cropland converted, two upland acres of crop receive a reduction of 43% (TN), 53% (TP), and 53% (SED).
- Tier 3 Nutrient Management Plan Implementation (standard and yield reserve program)
  - Nutrient management is applied to "Tier 2" levels plus 30% of the of the available crop and hay acres between "Tier 2" and "E3" levels in PA, VA, NY, and WV.
  - Tier 2 and E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
  - All crop and hay acres in MD and DE are fully implementing nutrient management plans.
  - Of the crop and hay acres available for nutrient management, 30% conforms to a yield reserve program where the land receives 25% less TN and TP than standard nutrient management applications - Do not receive more than 98% of TN and TP need.
  - Yield reserve program assumes farmer insurance for yield losses.
  - The remaining 70% of land available for nutrient management follows standard rules where crop and hay acres do not receive more than 130% of their TN and TP need.
- Tier 3 Manure excess
  - Excess nutrients resulting from the differences between manure generated and conforming to nutrient management rules and losses in agricultural land are reported.
  - It is assumed that all of the excess manure has alternative uses that do not affect loads to the Chesapeake Bay.
- Tier 3 Animal waste management/runoff control
  - Applied to "Tier 1" levels plus 60% of the of the available manure acres between "Tier 1" and "E3" levels.
  - Tier 1 ands E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
  - BMP reduction factors of 75% (TN and TP) are applied to protected manure acres.
- Tier 3 Farm Plans (non-nutrient management)

- Applied to “Tier 1” levels plus 70% of the of the available agricultural acres (crop, hay, and pasture) between “Tier 1” and “E3” levels.
- Tier 1 and E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
- Nutrient and sediment reduction factors for Farm Plans on high-till are 10% (TN) and 40% (TP and SED). Low-till and hay reduction factors are 4% (TN) and 8% (TP and SED) while the reduction factors for Farm Plans on pasture are 20% (TN) and 14% (TP and SED).

C Tier 3 Cover crops
- Applied to “Tier 1” levels plus 75% of the of the available cropland between “Tier 1” and “E3” levels.
- Tier 1 and E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
- BMP reduction factors of 35% (TN) and 15% (TP and SED) are applied to cover crop acres.

C Tier 3 Streambank protection with fencing
- Applied to “Tier 1” levels plus 75% of the of the available pasture land that can be protected between “Tier 1” and “E3” levels.
- Tier 1 ands E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
- BMP reduction factors of 75% for TN, TP, and SED are applied to pasture acres protected.

C Tier 3 Streambank protection without fencing
- Applied to “Tier 1” levels plus 25% of the available pasture land area to apply the BMPs to accounting for the acres protected by fencing.
- Tier 1 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes and streambank protection with fencing.
- BMP reduction factors of 40% for TN, TP, and SED are applied to pasture acres protected.

C Tier 3 Grazing land protection
- Applied to “Tier 1” levels plus 50% of the of the available pasture land between “Tier 1” and “E3” levels.
- Tier 1 ands E3 levels are revised following the same methodologies but account for previously applied BMPs that involve landuse changes.
- BMP reduction factors of 50% (TN) and 25% (TP) are applied to protected pasture acres.

4.2 2010 Tier 3 Urban and Mixed Open BMPs

C Tier 3 Reduction in 2000–2010 urban growth
- 20% of the projected pervious and impervious urban growth in PA, MD, VA, and DC between 2000 and 2010 is not developed.
- It is assumed that 65% of the reduction in projected urban growth is retained in forest, 20% in mixed open, and 15% in agriculture.

  - Landuse conversions of pervious and impervious urban to forest, mixed open, and agriculture (crop, hay, and pasture).
- Tier 3 Environmental site design/low-impact development on new development
  - Environmental site design/low-impact development practices applied to all new development between 2000 and 2010.
  - Environmental site design and low-impact development practices are designed to reduce TN by 45%, TP by 57%, and SED by 87%.
- Tier 3 Stormwater retrofits on recent development
  - 60% of recent development (1986–2000) is retrofitted with a suite of practices to reduce nutrients and sediment in stormwater runoff by 20% (TN), 30% (TP), and 65% (SED).
- Tier 3 Stormwater retrofits on old and recent development
  - 20% of pre-1986 urban land and 1986–2000 recent development has stormwater management practices that reduce nutrients and sediment in runoff by 20% (TN), 30% (TP), and 65% (SED).
- Tier 3 Riparian grass buffers on urban
  - Urban grass buffer acreage is reduced 30% below “Tier 1"levels and is converted to urban forest buffers.
  - Tier 1 levels are revised following the same methodology but account for previously applied BMPs that involve landuse changes.
  - The assumption is maintained that all urban stream reaches have 50-foot riparian buffers in either forest or grass except where urban disturbance has altered a stream reach beyond repair/restoration (i.e., impervious surface).
  - There is no upland benefit associated with grass buffers on urban.
- Tier 3 Riparian forest buffers on urban
  - Urban forest buffer acreage is increased by the same amount as the reduction in urban grass buffers.
  - The assumption is maintained that all urban stream reaches have 50-foot riparian buffers in either forest or grass except where urban disturbance has altered a stream reach beyond repair/restoration (i.e., impervious surface).
  - There is no upland benefit associated with forest buffers on urban.
- Tier 3 Riparian forest buffers on mixed open
  - Mixed open forest buffer acreage is increased from “Tier 1” levels by the same amount as the increase in urban forest buffers between “Tier 1” and Tier 3.
  - Tier 1 levels are revised following the same methodology but account for previously applied BMPs that involve landuse changes.
  - Landuse conversion of mixed open to forest.
  - There is no upland benefit associated with forest buffers on mixed open.
- Tier 3 Nutrient management on urban and mixed open
  - It is assumed that 75% of pervious urban and 75% of mixed open land are under nutrient management.
  - BMP reduction factors of 17% (TN) and 22% (TP) are applied to acres under nutrient management.

4.3 2010 Tier 3 Forest Harvest BMPs

- It is assumed that forestry BMPs designed to minimize the environmental impacts from timber harvesting , such as road building and cutting/thinning operations, are properly installed on all harvested lands with no measurable increase in nutrient and sediment discharge.
- The assumption is based on maintaining the state of forest loads as measured during the calibration of the Bay Program Watershed Model.

4.4 2010 Tier 3 Septic BMPs

- 100% of new treatment systems between 2000 and 2010 and 1% of existing systems employ denitrification technologies and are maintained through regular pumping to meet an edge-of-septic-field TN concentration of 10 mg/L or 2.3 lbs TN per person-year.
- The 1% of existing systems represents failed systems and opportunities for upgrades.
- The remaining existing systems are at current edge-of-septic-field concentrations and flows per system.
- Septic BMPs incorporate submissions from the Bay-basin jurisdictions of the current number of systems employing denitrification technologies (50% TN reduction) and those with regular maintenance through pumping (5% TN reduction).

4.5 2010 Tier 3 Point Source BMPs

- Tier 3 Significant municipal wastewater treatment facilities
  - Nitrogen – All significant POTWs are at 2010 projected flows and reach and maintain effluent concentrations of 5 mg TN/l (annual average) including those facilities that planned to go to NRT by 2010.
  - Phosphorus – POTWs are at 2010 projected flows and reach and maintain effluent concentrations of 0.5 mg TP/l (annual average) or the permit limit, whichever is less.
- Tier 3 Significant industrial dischargers
  - 2000 flows and generally maintain effluent concentrations that are 80% less that those in Tier 1 or the permit limit, whichever is less.
- Tier 3 Non-significant municipal wastewater treatment facilities
  - 2000 TN and TP effluent concentrations applied to 2010 projected flows.

4.6 2010 Tier 3 Combined Sewer Overflow BMPs

- There is a 43% reduction in the current discharge from DC combined sewer overflows, the only CSO loads among all jurisdictions for which the Bay Program has nutrient load data specifically quantified in the model simulation.
- The reduction from 2000 loads is what is expected by the District to be achieved by 2010.

4.7 2010 Tier 3 Atmospheric Deposition BMPs

Tier 3 atmospheric deposition assumes existing regulatory nitrogen oxide emissions controls under the 1990 Clean Air Act, as well as more aggressive but voluntary emissions controls on the utility sector, projected for the year 2020. Estimated changes in deposition for the Tier 3 scenario include the following controls on nitrogen oxide emissions:

- 2020 non-utility (industrial) point source and area source emissions with no additional controls than Tiers 1 and 2.
- 2020 mobile source emissions with the effect of the Tier II tail pipe standards on light duty vehicles being felt, and the implementation of the heavy duty diesel standards to further reduce NOx emissions. Same as Tier 2 controls.
- 2020 utility emissions with major (90%) reductions in SO2 and aggressive 20-state NOx SIP call reductions through utilities going to 0.10 lbs/MMbtu for the entire year—no longer just seasonal.

The impacts of Tier 3 emissions and deposition to the Bay watershed's land area and non-tidal waters are part of the reported nutrient loads from the individual landuse source categories, i.e., agriculture, urban, mixed open, forest, and non-tidal surface waters). The reported loads; however, usually do not include contributions from atmospheric deposition to tidal waters although the water quality responses, as measured by the Estuary Model, account for this source at levels prescribed by Tier 3.

4.8 2010 Tier 3 Shoreline Erosion BMPs

- Tier 3 shoreline erosion controls include structural and non-structural practices at 2000 levels.

The impacts of Tier 3 shoreline erosion controls are not included in the reported Watershed Model loads although the water quality responses, as measured by the Estuary Model, account for this source at BMP levels prescribed by Tier 3.

5. BAY-WIDE LOADS FOR 2000, TIERS 1 TO 3, AND E3

The following graphs (**Exhibits A-1** through **A-3**) depict modeled Bay-wide nutrient and sediment loads delivered to the Chesapeake Bay by major source category for each of the tier scenarios as well as E3. As references, the estimated loads for the year 2000 are also portrayed.

As is common for reporting purposes, the delivered loads are a yearly average of loads simulated over a 10-year period (1985–1994). This removes considerations of the effects of variable precipitation levels or flows on loads. Also, nutrient loads are reported in units of million pounds per year while sediment fluxes are in million tons per year.

Load reductions through the tiers to E3 show the impact of most point and non-point source BMPs employed in the design of the scenarios as described previously in this Appendix. Atmospheric deposition to the Bay watershed's land area and non-tidal waters are part of the reported loads but the loads do not include contributions from atmospheric deposition to tidal waters. In addition, the reported loads do not reflect shoreline erosion controls employed in the scenarios. The water quality responses as measured by the Estuary Model; however, account for both atmospheric deposition to tidal waters and shoreline erosion at levels prescribed by the tiers and E3.

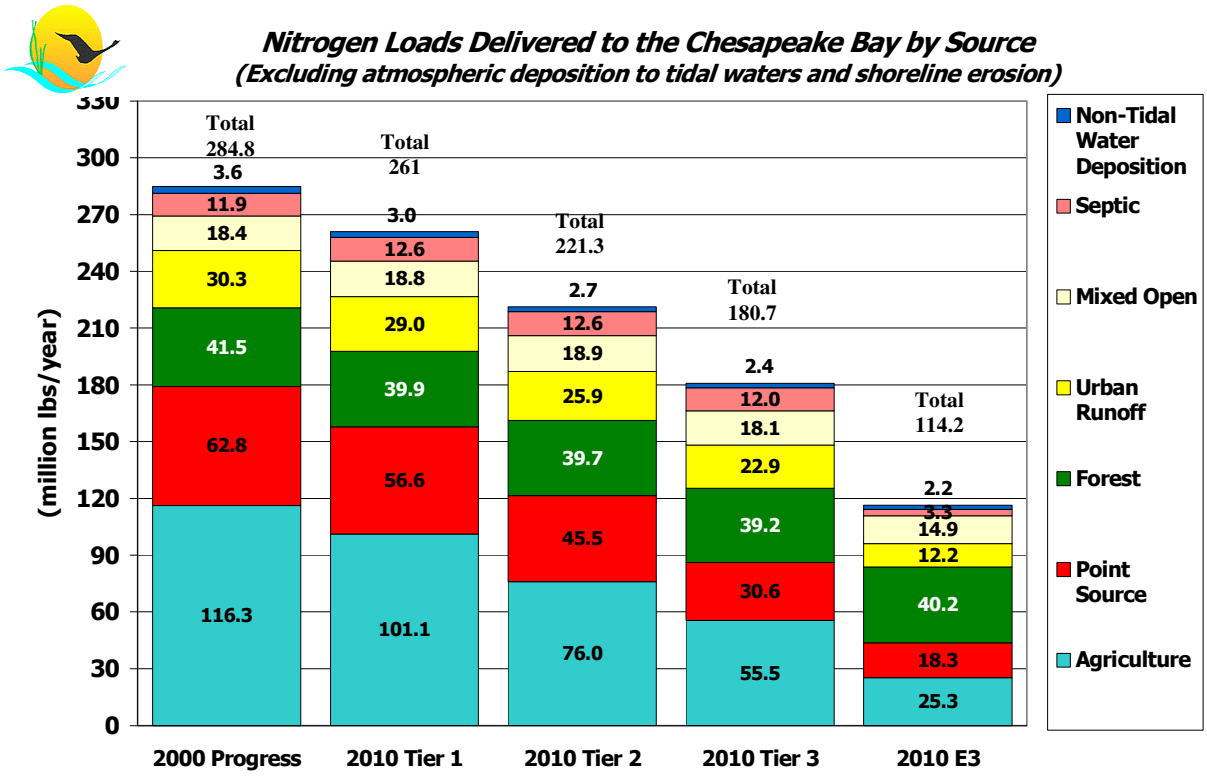

Exhibit A-1: Nitrogen Loads Delivered to the Chesapeake Bay by Source

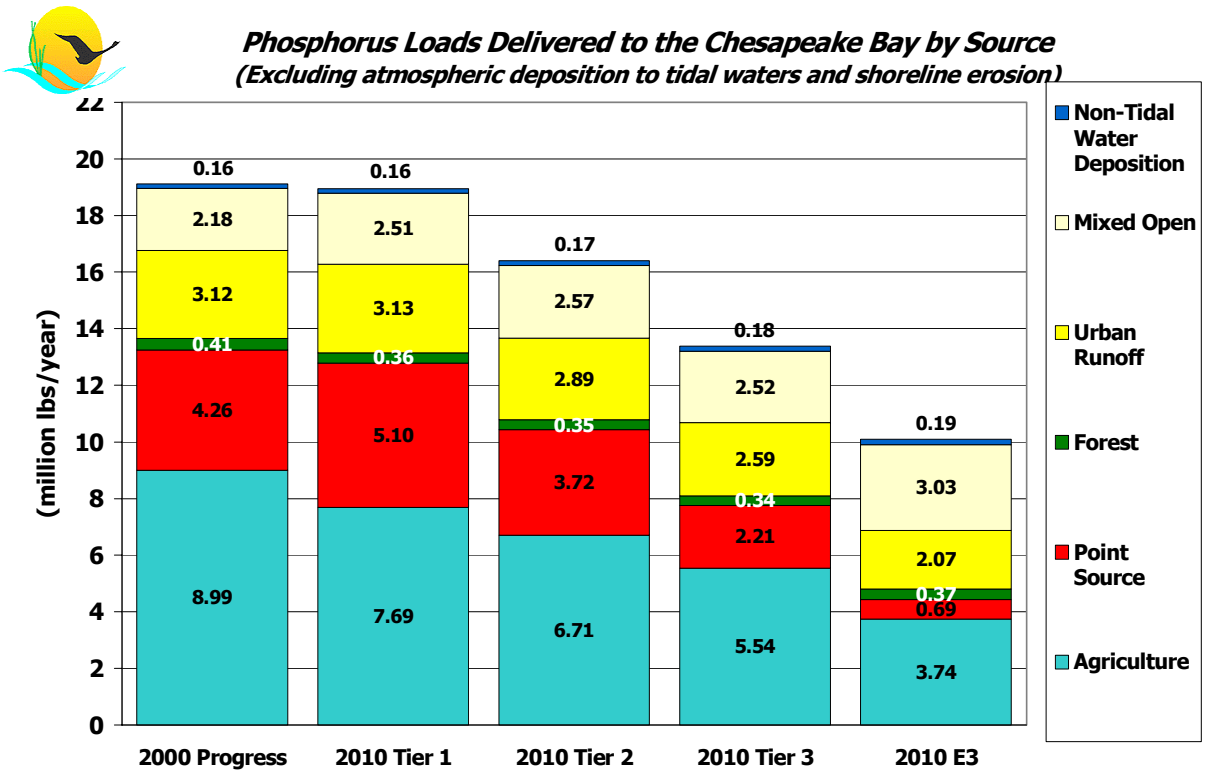

Exhibit A-2: Phosphorus Loads Delivered to the Chesapeake Bay by Source

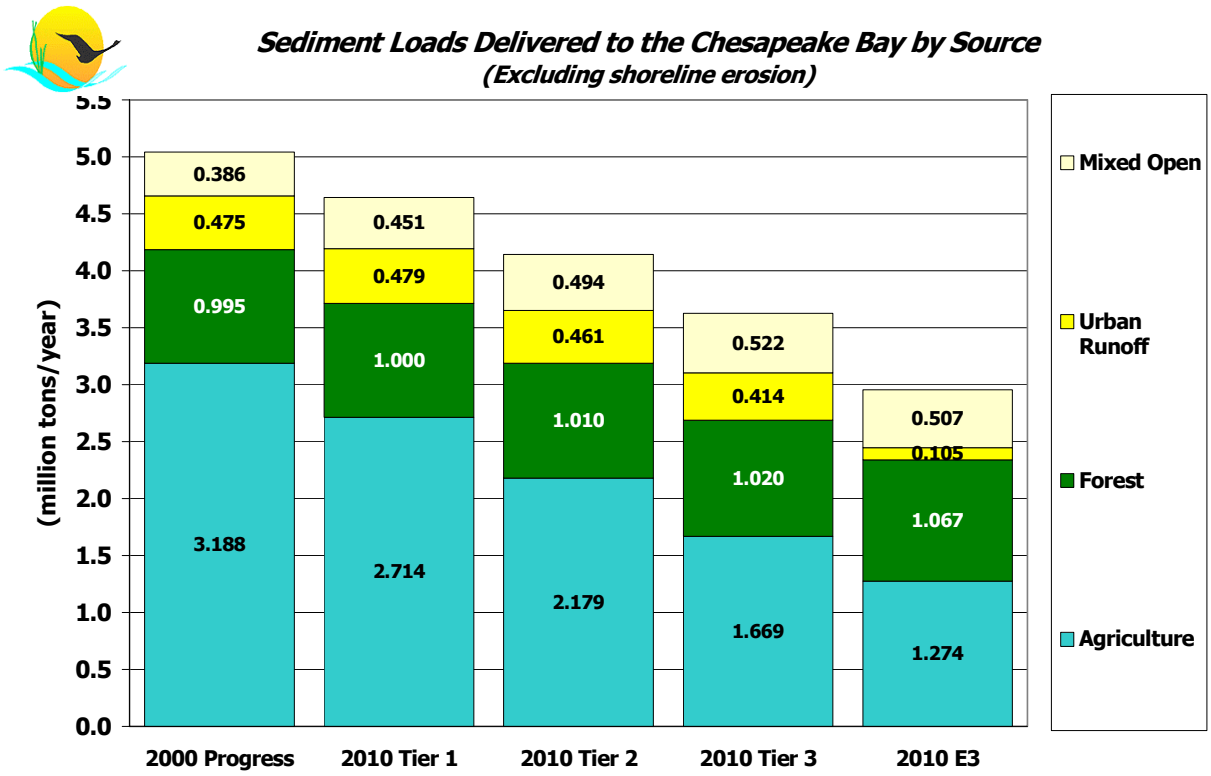

Exhibit A-3: Sediment Loads Delivered to the Chesapeake Bay by Source

It is important to note that landuses and animal populations change considerably between 2000 Progress and the tiers and E3, which are rooted in projected 2010 landuses and populations. Therefore, nutrient applications to agricultural land change considerably over the decade. Also, the number of septic systems and the flows from municipal wastewater treatment facilities shift dramatically from 2000 to 2010 based on an increasing population. For example, point source phosphorus loads increase from 2000 to 2010 Tier 1 because of increases in POTW flows which, unlike nitrogen, are not offset by technologies to reduce this nutrient in effluents.

In addition to changes between 2000 and the 2010 tier and E3 scenarios, it is imperative to consider landuse changes among the tiers and E3 due to increasing non-point source BMP implementation levels. For example, sediment loads from forested land increase through the tiers to E3 because the land area increases as, for example, more and more riparian buffers are planted on agricultural and urban land. In addition, increases in loads from mixed open land is attributable to greater acreage in this category as, for example, agricultural land is retired.

6. INFLUENCE OF EMISSION CONTROLS AND ATMOSPHERIC DEPOSITION ON LOADS

The impacts of emission controls and the resultant lower atmospheric deposition to the Bay watershed's land area and non-tidal waters are part of the reported nutrient loads from the individual landuse source categories in the tiers and E3, i.e., agriculture, urban, mixed open, forest, and non-tidal surface waters. As mentioned previously, the reported loads however, usually do not include contributions from atmospheric deposition to tidal waters although the water quality responses account for this source.

To estimate the effects of only the tier and E3 air emission controls—without the influences of other point and non-point source BMPs—the following histograms (**Exhibit A-4**) show changes in atmospheric deposition of nitrogen to the watershed's land area and non-tidal waters and the response in delivered loads. In this model study, all land uses, fertilizer applications, point sources, septic loads, and BMP implementation levels were held constant at 2000 conditions. Only atmospheric deposition varied.

What these scenarios say is that "If projected emission and deposition reductions associated with the tiers and E3 were realized today (2000), loads to the Chesapeake Bay are estimated to be the following." As references, Tier 1 and Tier 2 loads from the watershed are shown in the graphics.

As can be seen, atmospheric deposition to the watershed progressively declines from 2000 through the tiers to E3 as more emission controls are included in the model simulation. But note how the loads from the watershed's land area and non-tidal waters respond to these progressive emission and deposition reductions, but to a much smaller degree.

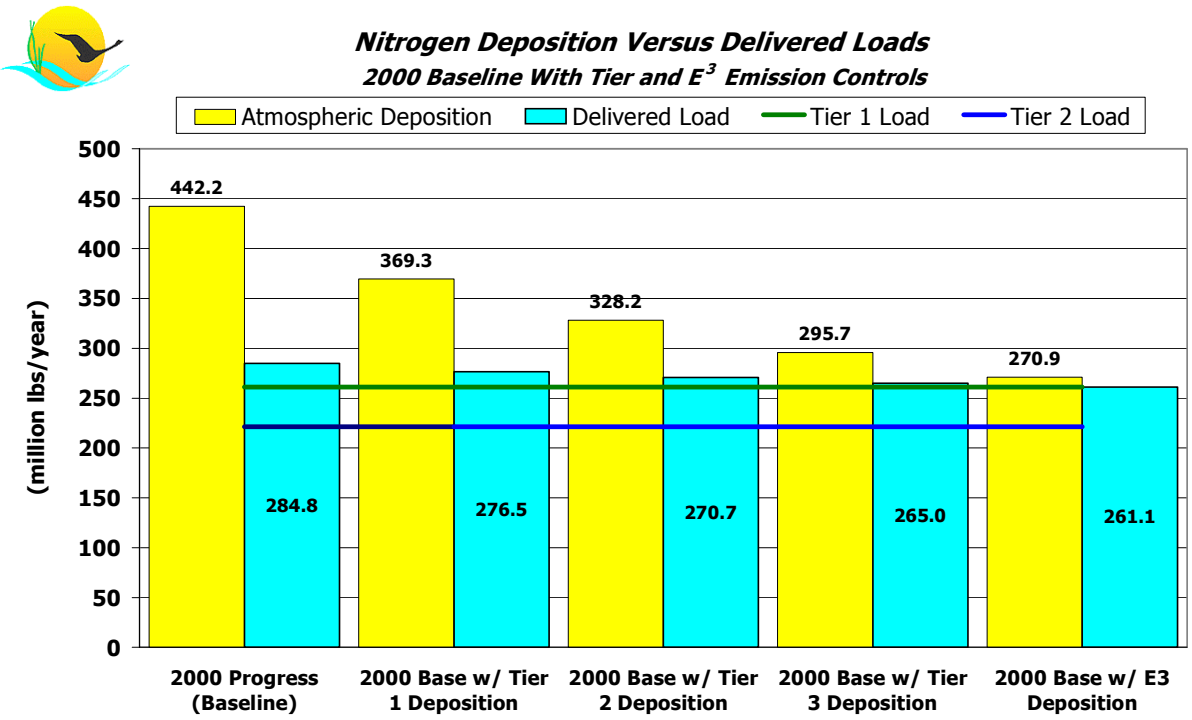

Exhibit A-4: Nitrogen Deposition Versus Delivered Loads

The most significant reason for the dampened response is that the Chesapeake Bay watershed is about 57% forested—or 57% of atmospheric nitrogen deposits on forests—and among landuses, forests have the greatest potential to uptake nitrogen. Generally, forests in the Bay basin are not nitrogen-saturated—whereby they leak nitrogen to sub-surface or ground water.

The largest single source of nitrogen loads to the Chesapeake Bay is agriculture where nitrogen-based commercial fertilizers and animal manure applied to agricultural land are currently eight times the input of nitrogen to agricultural land from atmospheric deposition.

It is the impacts of emission controls on loads that are important in evaluating water quality responses, the development of a costing tool, and the establishment of tributary strategies—rather than the contribution to loads from atmospheric deposition. Understanding the loading responses to changes in deposition better addresses to what degree the loads can be controlled. The proportion of the loads attributed to atmospheric deposition changes dramatically from 2000 through the tiers and E3 because of both variable emission controls and changes in landuses that the atmospheric nitrogen is deposited to.

In the most dramatic case, deposition of nitrogen to the watershed decreases 171 million lbs/year from 2000 to 2010 E3. If this reduction in deposition were realized today, (i.e., deposition was to 2000 landuses with all other present conditions), nitrogen loads to the Bay would decrease 21 million lbs/year or would be at levels associated with the Tier 1 scenario.

It is important to note that E3 levels of emission controls are considered to be the current limits of technology with aggressive controls on all major sources - utilities, mobile, and industrial - and follow the format of defining E3 BMPs. It is not important that these emission controls would be voluntary, as opposed to regulatory, as E3 implementation levels for almost all other point and non-point source BMPs did not consider physical limitations, participation rates, and costs. In other words, it was not the intent of the tiers to establish what can and cannot be done through management actions - either regulatory or voluntary - as this is the responsibility of Bay watershed jurisdictions. However, the air scenarios involve action taken by 37 states not just the basin states.

ATTACHMENT 1 TO APPENDIX A

May 6, 2002

TO: Rebecca Hanmer, Co-Chair
Water Quality Steering Committee

Jon Capacasa, Co-Chair
Water Quality Steering Committee

FROM: Rich Eskin, Chair
Use Attainability Workgroup

Mike Bowman, Chair
Tributary Strategy Workgroup

SUBJECT: Use of the E3 Scenario

This is a joint memo from the Chairs of the Water Quality Steering Committee Use Attainability Workgroup and the Nutrient Subcommittee Tributary Strategy Workgroup which recommending a course of action regarding the E3 scenario and its relation to the Use Attainability Analysis (UAA). In an attached 4/10/02 letter from Mike Bowman, chair of the Tributary Strategy Workgroup to Rich Eskin, chair of the Use Attainability Workgroup, Mike strongly recommends that a costing and economic analysis of E3 should not occur. The reasons for this position relate to inherent limitations in the E3 scenario including: 1) E3, in some cases, may not be physically plausible, and 2) cost assumptions do not realistically reflect increasing costs as implementation levels increase.

Having considered this recommendation, the UAA workgroup also agrees. However, we both believe that the E3 scenario still provides valuable information because it represents the limits of the watershed's reduction potential. This is primarily important for two reasons. Firstly, the UAA's major function is to provide support a decision on attainability. Human-caused conditions that cannot be remedied is a critical threshold for the attainability question that must be answered by the UAA. The E3 scenario is a good approximation of that. Secondly, knowing what the upper boundary of our reduction potential is will help us determine what level of water quality can be achieved with currently known technology, and if the criteria we develop are within reach. Note that costs or economics are not required when using E3 for these purposes.

Thus, we recommend to the Water Quality Steering Committee, that we do not perform a cost or economic analysis on E3 because it does not reflect the level of reality which would warrant such analyses. Rather, we plan to continue to use E3 to assist us in estimating the upper boundary of our watershed's reduction potential.